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U. S. DEPARTMENT OF AGRICULTURE

Factors in Developing Grades and Standards for Blackstrap Molasses for Feed

Marketing Research Division
Agricultural Marketing Service
U.S. Department of Agriculture
In Cooperation With The Texas Agricultural Experiment Station

PREFACE

This study was made by the Texas Agricultural Experiment Station, College Station, Texas, under contract with the United States Department of Agriculture. The report is part of a broad program of continuing research designed to reduce the cost of marketing farm products.

C. B. Gilliland and O. C. Hester, agricultural economists, Marketing Research Division, Agricultural Marketing Service, assisted in planning and giving general direction to the study, arranged for samples from the Bureau of Customs, and made helpful suggestions throughout the study including the final preparation of the manuscript for printing.

Stella Wilkes and Janice Doss, technicians in the Department of Biochemistry and Nutrition at the Texas A. & M. College, conducted the analyses. Reed McDonald, chief of the Texas Feed Control Service, arranged for the collection of the Feed Control molasses samples; E. A. Epps, official chemist, Louisiana Department of Agriculture and Immigration, supplied samples of molasses produced in Louisiana, Hawaii, and Puerto Rico. Nathan Mayo, Commissioner, Florida Department of Agriculture Inspection Bureau, supplied samples of molasses produced in Florida; and William L. Hunter, chief, Bureau of Field Crops, California Department of Agriculture, supplied samples of molasses distributed in California.

The Texas Agricultural Experiment Station, College Station, Texas, contributed further to the study by conducting the biological assay of nutrients in molasses, which was not a part of the contract.

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CONTENTS

Page

Summary 5

Introduction 7

Collection and source of samples 8

Selection of constituents of molasses to be tested in study 10
  Sugar, moisture, ash, foreign matter 10

Composition of molasses 11
  Degrees Brix, moisture, ash, and sugar 11

Physical properties 13

Price of molasses 18
  Comparison of cost of carbohydrates 20

Recommended analyses to be used for grading molasses 21
  Bioassay of nutrients in molasses 22

Recommendations for grading and labeling 24

Appendix: Methods of analyses 25
  Determination of total invert sugar 25
  Determination of moisture 26
  Determination of Brix 26
  Determination of protein 26
  Determination of ash 26
  Determination of relative viscosity 27
  Determination of foreign matter 27

TABLES

Page

1.--Composition of samples of molasses from various sources, analyzed in Texas, 1958 12
2.--Percentage of protein in molasses from various sources, analyzed in Texas, 1958 16
3.--Viscosity of 15 samples of molasses at 50° and 6° C., Texas, 1958 17
4.--Variations in viscosity of molasses at certain levels of moisture content, Texas, 1958 17

TABLES (Continued)

Page

5.--Height of precipitate in samples of molasses from various sources, percentage distribution, Texas, 1958 19
6.--Range of prices paid for molasses by feed manufacturers located at various distances from a Gulf Coast port, Texas, 1957-58 19
7.--Molasses containing different percentages of sugar: Quantity required to give 1 ton of carbohydrate, and cost of carbohydrate, Texas, 1958 20
8.--Range of moisture and sugar found in molasses at various degrees Brix, Texas, 1958 21
9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958 28

FIGURES

Page

1.--Percentage distribution of Feed Control samples of molasses with different degrees Brix and different percentages each of moisture, sugar, and ash 14
2.--Percentage distribution of Customs samples of molasses with different degrees Brix and different percentages each of moisture, sugar, and ash 15
3.--Percentage distribution of Feed Control and Customs samples of molasses with different viscosities at 50° C. (122° F.) 18

SUMMARY

A total of 466 samples of molasses were collected in 1957 and 1958 by the United States Bureau of Customs, inspectors of the Texas Feed Control Service, and officials of the State departments of agriculture of California, Florida, and Louisiana. All samples were analyzed for specific gravity (degrees Brix), viscosity at 50° C. (122° F.), and odor, and for moisture, ash, total sugar (carbohydrate), and foreign matter. Crude protein content of 167 samples and viscosity at 6° C. (43° F.) of 100 samples were also determined. The range in values for degrees Brix, moisture, ash, total sugar, and viscosity was large. Correlation between moisture and sugar was 0.6, which was higher than that for any other constituents. Approximately one-third of the molasses distributed in Texas for use in livestock feeds contained 27 percent or more water. Feeds containing 10 percent of this molasses would be highly susceptible to spontaneous heating and spoilage because of the high moisture content.

From biological assays it appears that the carbohydrate is by far the most important nutrient constituent in molasses and should be included in any measure of quality. Moisture content is critical in the control of spoilage in mixed feeds and should also be included in measuring quality.

Practically no relationship was found between the price users paid for blackstrap molasses and the quality as measured by total sugar, moisture, and degrees Brix of molasses. For example, in one area on the same day, molasses containing 51.5 percent total sugar and 27 percent moisture sold for about $9 more per ton than molasses containing 61.6 percent total sugar and 18.9 percent moisture. There was a general increase in price with increase in distance from port of entry or source. With molasses selling at $30 per ton, a ton of carbohydrate from molasses containing 43 percent total sugar cost $69.75 while a ton of carbohydrate from molasses with 53 percent total sugar cost $56.58.

It is recommended that molasses marketed for livestock feeds be identified according to the amount of moisture and carbohydrate present. It is suggested that the term "blackstrap" be used solely for cane molasses and that molasses from other sources be labeled to identify the source and the amounts of water and total sugar present.

The following guides or possible grades for blackstrap are recommended for consideration by sellers, buyers, and appropriate regulatory agencies:

(1) Superior Blackstrap Molasses--cane molasses containing 23.4 percent or less water and 53.5 percent or more total sugar.

(2) Blackstrap Molasses--Cane molasses containing 23.5 to 26.4 percent water and 48.5 to 53.4 percent total sugar.

(3) Utility Blackstrap--cane molasses containing 26.5 percent or more water and 42.5 to 48.4 percent total sugar.

The data indicate that any product containing less than 42.5 percent sugar and 26.5 percent or more water is a mixture. It is recommended that such a mixture be labeled to identify its source and its moisture and sugar content.

FACTORS IN DEVELOPING GRADES AND STANDARDS FOR BLACKSTRAP MOLASSES FOR FEED

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INTRODUCTION

The major use for blackstrap molasses is for animal feed, either in mixed feeds or in liquid form. The composition of blackstrap molasses varies between producing areas and between raw sugar mills within an area. Different handling and marketing practices add to the variability found in the product at the different stages in the marketing process.

Feed manufacturers using blackstrap molasses want a uniform product. Where uniformity in an ingredient cannot be obtained, the composition within a rather narrow range needs to be known.

Standards or grades based on nutrients present in molasses are desirable for the following reasons: (1) To insure users a product which can be fed or mixed in feed mixtures on a uniform basis, (2) to afford a basis for marketing molasses so that its value in relation to other foods and feeds can be determined accurately, and (3) to insure producers and distributors a price for molasses in proportion to nutrients furnished.

Feeding studies have been carried out by various groups, including the United States Department of Agriculture, State experiment stations, and private organizations, to establish the value of blackstrap molasses (cane molasses) as a feed. As a result of these investigations a variety of definitions and specifications have been proposed for various kinds of molasses used in livestock feeds. The quality of feeding molasses has been measured, for the most part, in degrees Brix for at least 50 years. This unit measures the specific gravity of a solution. For pure sucrose solutions it expresses the percentage of sucrose in the solution. However, in a crude product like feeding molasses, compounds such as lipids, proteins, inorganic salts, waxes, gums, and many other materials affect the degrees Brix in proportion to the amount of these materials present. Representatives of the molasses industry have reported that degrees Brix is a less accurate measure of the amount of sugar present in molasses produced in recent years than it was in that produced several years earlier. This change has been attributed chiefly to the practice of fertilizing and irrigating in the sugarcane-producing areas. With the increased use of fertilizer and irrigation the molasses contains more inorganic salts, which tend to increase the degrees Brix.

Earlier studies in the Texas Agricultural Experiment Station have shown that degrees Brix is an unreliable measure of sugar and moisture present in molasses. 1/ Since no uniform standards are available to measure the nutritive quality of molasses, data were collected for a study of the composition of feeding molasses entering the Gulf Coast area and of that distributed to various users in Texas, to determine the need for standards for blackstrap molasses produced and distributed for use in livestock feeds. The results of this study are described in this report.

COLLECTION AND SOURCE OF SAMPLES

Samples used in the study were taken by the United States Bureau of Customs, inspectors of the Texas Feed Control Service, and official representatives of the State departments of agriculture of California, Florida, and Louisiana. Official methods were used to take the samples so that each sample represented the average composition of the entire batch sampled. In this report the samples supplied by the Bureau of Customs are referred to as Customs samples and those supplied by inspectors of the Texas Feed Control Service are referred to as Feed Control samples. Those supplied by various State departments of agriculture are referred to as samples from the various States. Collection of samples was begun in October 1957 and completed in June 1958.

Samples of blackstrap molasses were collected at two stages in the marketing process: (1) From producers and distributors, to indicate the composition of molasses produced and available through imports, and (2) from feed mixers and other users, to indicate the composition of molasses reaching consumers. A large number of samples of molasses from the major supply areas over about a year were collected to provide the full range of quality of molasses encountered in the trade channels. No attempt was made to establish statistical differences between samples from different producing areas as the small number from several producing areas may not be representative of molasses from the area.

The numbers of samples from each of the various sources are summarized as follows:

Supplier of samples and source of molasses	Number of samples
Bureau of Customs:	
Cuba	27
Netherlands	1
Dominican Republic	1
Jamaica	1

1/ Richardson, L. R. and Halick, J. V. Moisture in Molasses as a Factor in the Heating of Feeds. Texas Agr. Expt. Sta. Bul 754. October 1952.

Supplier of samples and source of molasses	Number of samples
Bureau of Customs (Cont.):	
Ecuador	1
Mexico	175
Total	206
Texas Feed Control Service:	
Cane (blackstrap), distributors' stock	198
Refinery	15
Milo molasses	3
Total	216
Louisiana State Department of Agriculture:	
Louisiana	20
Hawaii	6
Puerto Rico	5
Total	31
California State Department of Agriculture:	
Hawaii	2
Philippines	1
Ecuador	1
Nicaragua	1
Total	5
Florida State Department of Agriculture	8
Total	8
Total samples analyzed	466

The 206 samples of molasses supplied by the Bureau of Customs entered the ports along the Gulf Coast from New Orleans, La., to El Paso, Tex. The weight of molasses was supplied for 95 samples by the Bureau of Customs. From this information it was estimated that the 206 samples represented a total of 795,180 tons or approximately 133,643,815 gallons of molasses which entered the Gulf Coast area during a period of 10 months.

Of the 216 samples supplied by the Texas Feed Control Service, 198 represented molasses delivered to consumers by molasses distributors. Of the 15 samples of molasses produced at a refinery in Texas, some were taken from the storage tanks at the refinery and some were collected from storage tanks of the consumer.

The Louisiana Department of Agriculture and Immigration obtained 1 sample each at 10 different raw sugar mills in Louisiana during October 1957, and another sample from each of the same mills again in December 1957. The mills were chosen to represent molasses produced by all raw sugar mills in Louisiana.

The samples supplied by the Florida Department of Agriculture were produced in Florida at 2 different locations.

A total of 466 samples from all sources were analyzed for degrees Brix, viscosity at 50° C. (122° F.), and odor, and for moisture, ash, total sugar, and foreign matter. The viscosity at 6° C. (43° F.) of 100 samples and the crude protein content of 167 samples were also determined.

The number of Customs samples collected at various Gulf Coast ports is shown below:

Where samples were collected and source of molasses	Number of samples
El Paso, Tex.:	
Mexico	90
Laredo, Tex:	
Mexico	77
Houston, Tex.:	
Mexico	3
Cuba	3
New Orleans, La.:	
Mexico	5
Cuba	22
Jamaica	1
Dominican Republic	1
Ecuador	1
Netherlands	1
Beaumont, Tex.:	
Cuba	2

The largest number came from El Paso and Laredo, Tex. These were samples of Mexican molasses. Because all the molasses entered these ports by tank car, each sample probably represented a smaller lot than those taken at other ports. All samples entered the other ports by tanker.

SELECTION OF CONSTITUENTS OF MOLASSES TO BE TESTED IN STUDY

Sugar, Moisture, Ash, Foreign Matter

Several factors were taken into consideration in deciding the constituents that would be determined in the molasses. The most important factor was the constituents that users felt affected the quality: (1) Sugar content or the nutrient equivalency to permit accurate gaging of its use in a mixed feed, (2) water content or percentage of solids, (3) mineral or ash content, and (4) dirt or foreign matter content. Other characteristics and reasons for their determination are described briefly as follows:

Brix.--Degrees Brix was included in the analyses in order to determine the relationship of this unit to the nutritional value of molasses.

Crude protein.--Approximately 20 percent of the samples were analyzed for crude protein (nitrogen x 6.25) to establish whether the amount present in molasses was sufficient to use as a constituent in any standard based on nutritional value.

Viscosity.--Viscosity is a measure of the relative rate of flow of a liquid. A standard for feeding molasses that is applicable on a national basis will have to consider the flow of molasses in different seasons and in cool and warm areas of the country. Preliminary studies showed that both the Customs and the Feed Control samples flowed at a rate which could be measured rapidly and accurately in the viscosimeter when the temperature was 50° C. or approximately 122° F. Therefore, the viscosity of all samples was determined at this temperature. It was then decided to measure the viscosity at a lower temperature to determine the viscosity ranges that would be practical in areas where the temperature is cooler than that along the Gulf Coast. A room was available in the laboratory which was maintained at a temperature of 6° C. or 43° F., and it was for this reason that 6° C. or 43° F. was chosen to measure the relative viscosity at a lower temperature. It soon became evident that the Customs samples were too heavy to be used under practical conditions, and the viscosity was measured on the Feed Control samples only.

The molasses samples were analyzed for degrees Brix, moisture, ash, sugar, and protein. The physical properties determined were viscosity, odor, and foreign matter.

COMPOSITION OF MOLASSES

Degrees Brix, Moisture, Ash, and Sugar

The average values, together with the ranges for moisture, ash, Brix, and total sugar, for molasses from various sources are given in table 1. [2] These data show that the variation between samples was large and that this condition existed regardless of the source of molasses. The range of various constituents in the Feed Control samples was as follows: Moisture, 18.0 to 31.2 percent; degrees Brix, 75.5 to 89.8; ash, 6.1 to 13.1 percent; and total sugar, 43.8 to 66.3 percent. One Customs sample from the Netherlands contained 20.6 percent ash, 17.3 percent total sugar, and 20 percent protein. This sample, even though it was labeled blackstrap molasses, was beet molasses or had been mixed with some other product.

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[2] Composition of all the samples is given in the Appendix, table 9.

Table 1.--Composition of samples of molasses from various sources, analyzed in Texas, 1958

Source of molasses	Samples	Moisture		Ash		Brix		Sugar	
		Average	Range	Average	Range	Average	Range	Average	Range
	Number	Percent	Percent	Percent	Percent	Degrees	Degrees	Percent	Percent
Texas:									
Sugarland	15	25.2	23.8-26.7	7.9	6.9-9.2	79.7	78.9-80.5	52.7	49.9-54.2
Molasses delivered to consumers	198	25.3	18.0-31.2	8.3	6.1-13.1	78.7	75.5-89.8	50.7	43.5-58.9
Milo molasses	3	21.6	19.9-22.6	4.0	2.0-7.0	77.2	76.9-77.4	53.1	52.2-53.6
Mexico	175	19.2	14.4-28.3	13.0	8.8-16.4	90.3	80.1-96.8	57.5	47.9-59.2
Cuba	27	18.8	17.4-21.3	8.8	6.7-10.5	87.5	84.9-95.3	56.9	54.2-61.3
Louisiana	20	22.8	13.9-27.9	9.1	7.7-10.7	84.7	79.1-94.1	55.5	49.3-63.3
Hawaii	8	20.7	18.4-24.3	10.9	8.4-12.4	86.7	84.3-88.3	48.8	43.8-56.5
Puerto Rico	5	18.4	16.2-20.5	8.5	7.2-10.6	88.6	87.0-90.3	56.1	50.1-60.3
Florida	8	21.8	17.0-27.4	9.8	8.6-11.4	85.2	78.4-88.5	51.2	48.5-55.2
Other foreign areas 1/	7	18.5	16.3-24.0	9.5	5.5-20.6	87.2	80.9-90.8	54.7	17.3-66.0

1/ Includes molasses from Dominican Republic, Ecuador, Jamaica, Netherlands, and Nicaragua.

Charts showing distribution of the Feed Control samples with different degrees Brix, percent of moisture, total sugar, and ash are given in figure 1.

These charts show that the major portion of the samples are within the medium range for each constituent. The medium range and total percentage of samples falling within this range were: 79 to 80 degrees Brix, 62.2 percent; 24 to 27 percent moisture, 81.2 percent; 49 to 53 percent total sugar, 73.2 percent; and 7 to 9 percent ash, 88.3 percent.

Charts showing similar data for Customs samples are given in figure 2. A majority of samples for each constituent fell within the following ranges: Degrees Brix, 87 to 90 and 93 to 94 plus; moisture, 16 to 19 percent; sugar, 54 to 56 percent; and ash, 12 to 15 percent.

Crude protein.--Crude protein, when calculated by multiplying the nitrogen by the factor 6.25, includes all other compounds containing nitrogen as well as protein. The average amounts of crude protein together with the range and number of samples analyzed from different sources are summarized in table 2. According to F. B. Morrison (Feeds and Feedings, Appendix, table 1, Average composition and digestible nutrients) the protein in cane blackstrap molasses is nondigestible and, therefore, is not available to the animal. [3] Even if all the nitrogen were present as protein and available with feeds containing 10 percent of most molasses, this source would furnish less than 0.4 percent protein. It is for this reason that protein was not determined in all the samples used in this study.

The samples of molasses produced in Florida and one sample from the Netherlands were unusually high in crude protein. Crude protein includes all nitrogenous compounds, whether protein or nonprotein, and it may include some inorganic nitrogen. The compounds containing nitrogen were not determined in the Florida or Netherlands samples, but it is probable that a large portion of the nitrogen was nonprotein. Further investigations would need to be carried out to determine the source of nitrogen present before definite conclusions can be drawn concerning the nutritive value of this high level of crude protein.

The Netherlands sample, which represented a total of slightly over 900,000 gallons of molasses, was too low in sugar and too high in ash to be classified as blackstrap molasses. However, it is a type of product that is sometimes marketed as blackstrap.

Physical Properties

Viscosity.--Viscosity was determined on all samples at 50° C. (122° F.) and on 100 Feed Control samples at 6° C. (43° F.) to establish the relationship, if any, between this property and nutrient value, and to find the amount of water required in different areas of the country and in different seasons to facilitate handling. The unit used to measure viscosity was the centistoke value. A small centistoke value indicates that the molasses flowed freely and

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[3] Morrison, F. B. Feeds and Feeding. 22d ed. 1,165 pp., illus. Ithaca, N. Y. 1956.

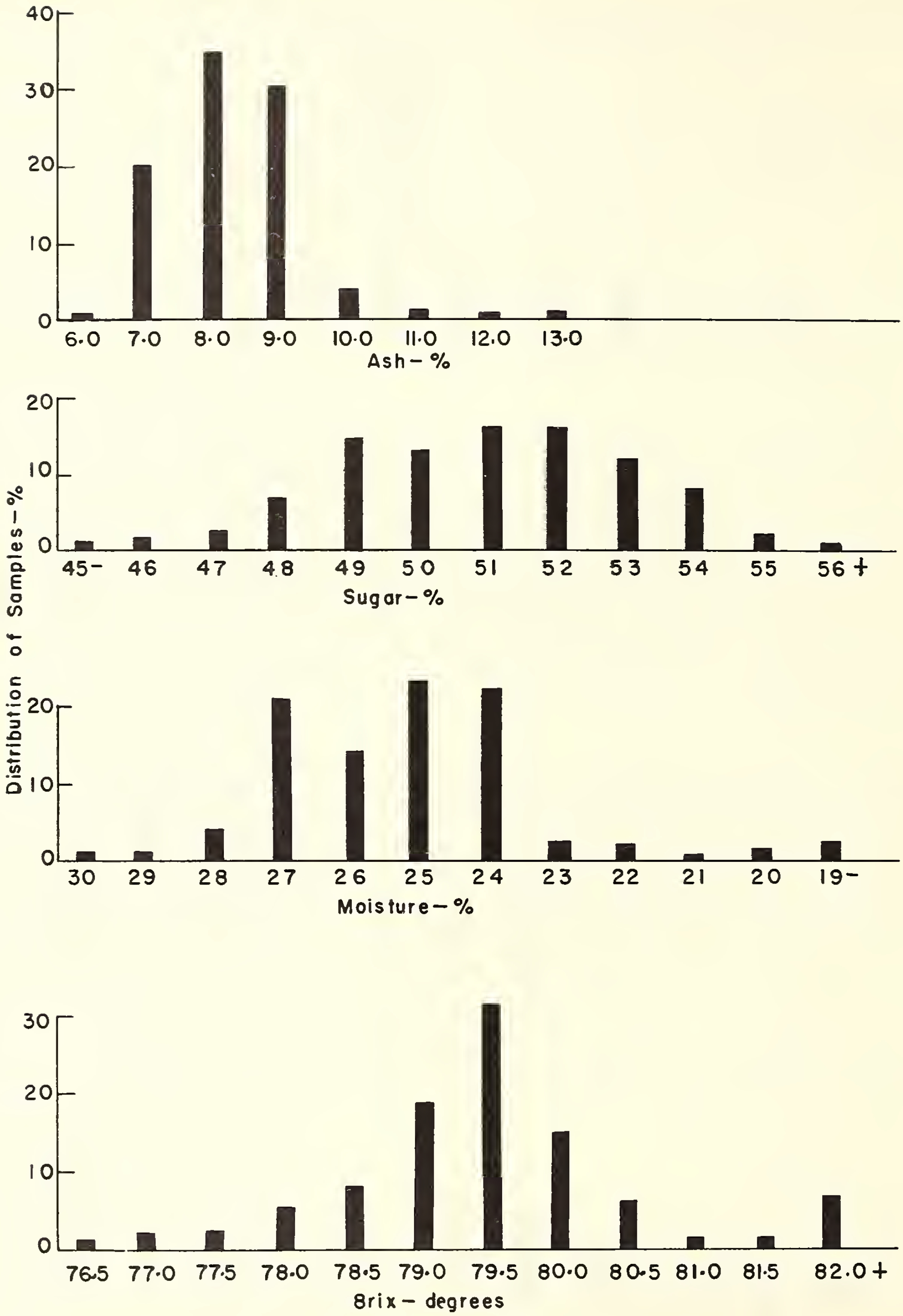

Figure 1.--Percentage distribution of Feed Control samples of molasses with different degrees Brix and different percentages each of moisture, sugar, and ash

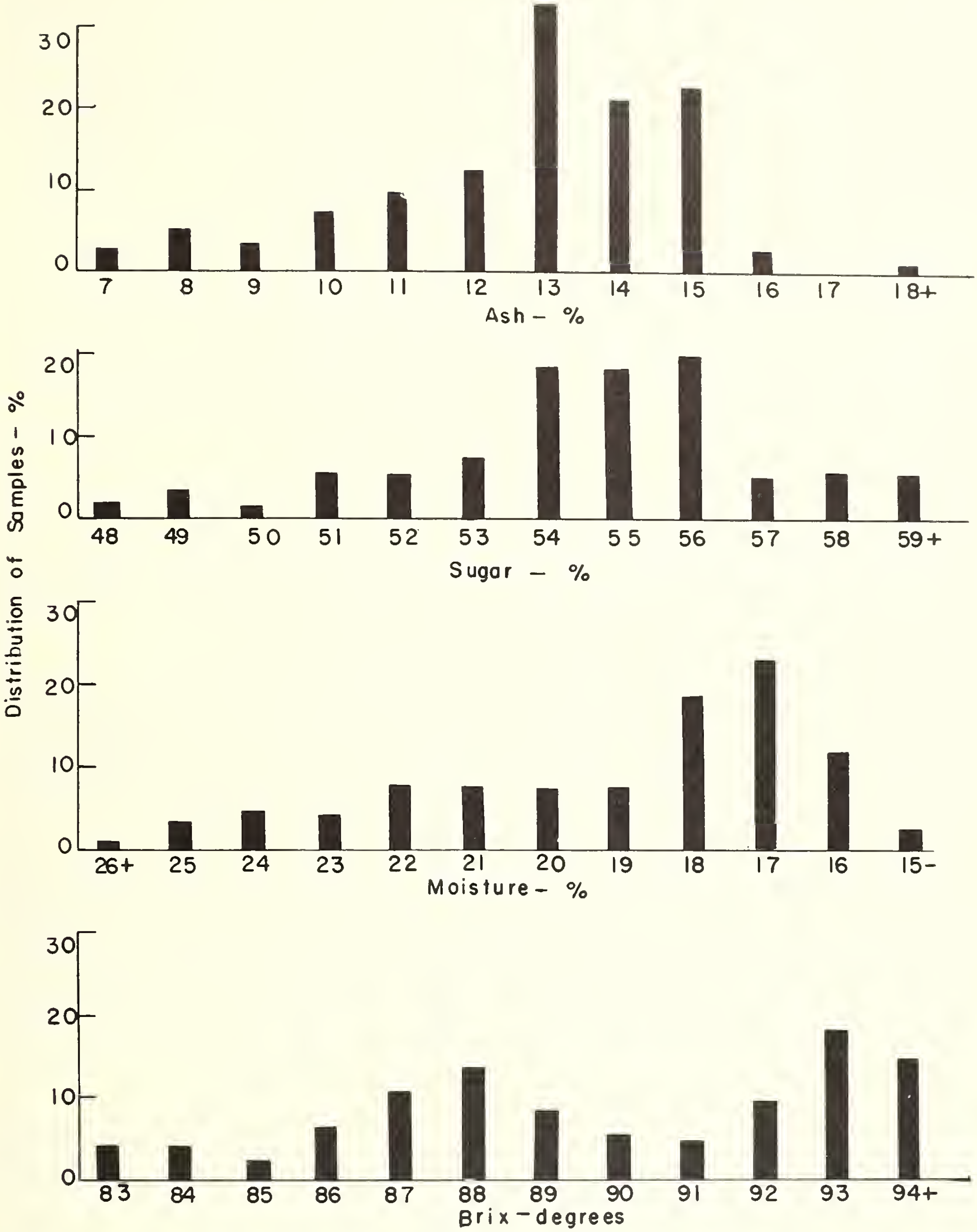

Figure 2.--Percentage distribution of Customs samples of molasses with different degrees Brix and different percentages each of moisture, sugar, and ash

Table 2.--Percentage of protein in molasses from various sources, analyzed in Texas, 1958

Source of molasses	Samples	Protein	
		Average	Range
	Number	Percent	Percent
Texas:			
Sugarland	9	2.8	2.1 - 4.2
Other	53	3.0	1.7 - 4.6
Florida	8	8.9	6.4 - 15.4
Louisiana	12	2.9	1.8 - 4.1
Hawaii	8	3.6	2.3 - 4.0
Puerto Rico	5	4.3	3.3 - 5.7
Mexico	47	2.2	1.6 - 3.5
Cuba	18	3.4	2.6 - 4.7
Netherlands 1/	1	20.0	20.0
Other foreign areas 2/	6	2.4	1.2 - 3.9

1/ A mixture not considered as blackstrap.

2/ Includes molasses from Dominican Republic, Ecuador, Jamaica, Nicaragua and the Philippines.

an increase in centistoke value indicates that the molasses became more viscous. Viscosities at 50° C. and at 6° C. of a few samples of molasses are given in tables 3 and 4 to illustrate the relationship of viscosity to moisture content and degrees Brix. The correlation between viscosity and sugar was very low and, therefore, viscosity is not related to nutritive value.

Charts in figure 3 for the distribution of Customs and Feed Control samples with different viscosities (centistoke value) show that most of the Feed Control samples had a low viscosity while most of the Customs samples had a high viscosity. From the data in table 3 it is doubtful whether molasses with a viscosity above 27 centistokes at 50° C. would be practical. These data indicate that the addition of some water to most of the Customs samples would be required. The amount to be added is discussed in the section on analyses that should be used as a basis for grades of molasses.

Foreign matter.--The amount of foreign matter in 400 or 85.8 percent of the samples was negligible. A total of 66 samples contained foreign matter as follows: Excess pulp, 19 or 4.1 percent; dead insects, 12 or 2.6 percent; and material classified as burnt residue, 35 or 7.5 percent.

Precipitate.--When diluted with water, a large number of the samples contained an insoluble material which settled out after standing overnight. To determine the relative amount of precipitate in the various samples, 80 grams

Table 3.--Viscosity of 15 samples of molasses at 50° and 6° C., Texas, 1958

Brix	Moisture	Viscosity at-- 50° C.	Viscosity at-- 6° C.
Degrees	Percent	Centistokes	Centistokes
79.8	28.3	75	1,502
78.8	29.7	92	1,725
79.3	25.9	176	6,545
78.8	27.1	176	4,914
79.0	27.3	186	6,441
79.0	26.2	186	6,188
79.5	22.9	250	9,727
79.4	23.5	250	9,312
79.8	23.8	266	9,390
79.6	25.1	269	13,647
79.7	23.8	289	13,802
79.4	24.8	295	14,483
79.5	24.3	336	14,198
84.0	22.2	607	45,000
84.4	18.5	907	50,000

Table 4.--Variations in viscosity of molasses at certain levels of moisture content, Texas, 1958

Number of samples	Range of moisture content	Range of viscosity
	Percent	Centistokes
6	16.4 - 16.5	436 - 4,737
10	18.2 - 18.3	829 - 2,460
4	20.6 - 20.7	777 - 1,601
2	22.2 - 22.3	266 - 607
9	24.4 - 24.5	215 - 291

of molasses was used for each sample. The relative height of the precipitate was a measure of the amount of the precipitate present regardless of the amount of water added. The percentages of samples from different sources showing various amounts of precipitate in inches are summarized in table 5. In general, the Customs samples contained the largest amount of insoluble precipitate. The amount in samples from the refinery in Texas and from those in Louisiana, Hawaii, Puerto Rico, and Florida was small.

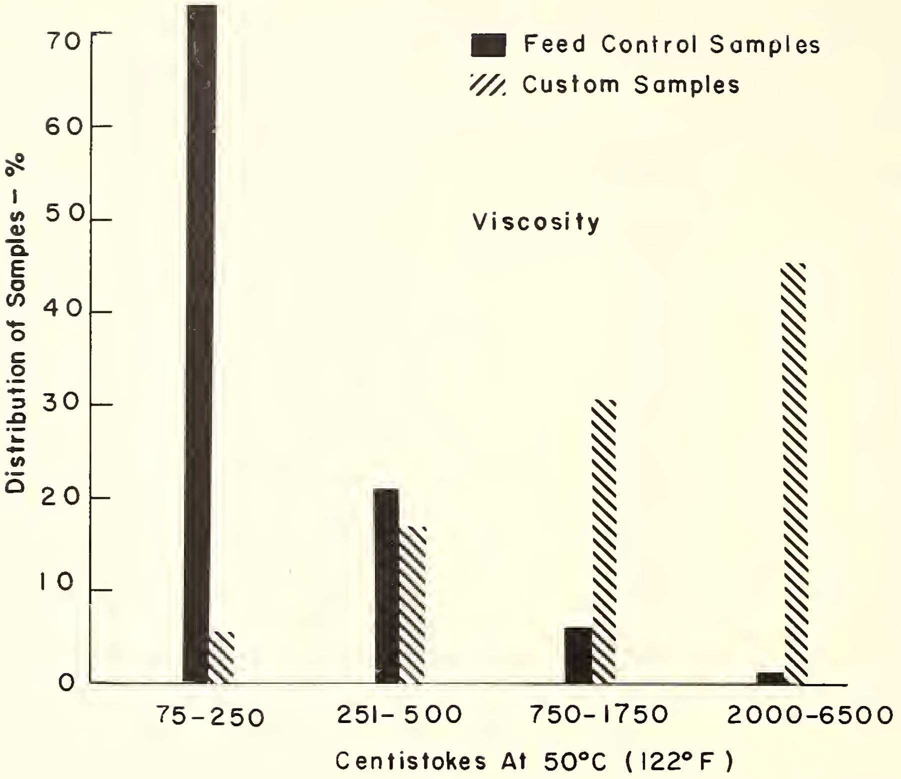

Figure 3.--Percentage distribution of Feed Control and Customs samples of molasses with different viscosities at 50° C. (122° F.)

Odor.--It was difficult to distinguish differences in odor. Three different persons attempted to classify the samples in groups according to some characteristic odor, but their decisions seldom agreed. A few Feed Control samples with high moisture contained a large amount of gaseous substance and most of these samples were described as having either pungent or fermented odor. It is doubtful whether the nutritive value of these samples would be any lower than those characterized as having a normal odor.

PRICE OF MOLASSES

Data showing the range of prices paid for molasses by consumers at various distances from a Gulf Coast port are summarized in table 6. For purposes of analysis it was assumed that the molasses was distributed from Houston, Tex., a major port of entry, unless the information supplied by the feed inspectors showed otherwise, and that the price given was the delivered price. In general, Table 5.--Height of precipitate in samples of molasses from various sources, percentage distribution, Texas, 1958

Supplier of samples or source of molasses	Percentage of samples in which height of precipitate was-- [1/]					
	0	0.5 inch	1.0 inch	1+ inch	2.0 inches	2+ inches
	Percent	Percent	Percent	Percent	Percent	Percent
Texas Feed Control Service	17	78	3	2	---	---
Bureau of Customs	13	29	16	22	8	12
Texas sugar refinery	67	33	---	---	---	---
Louisiana raw sugar mills	65	35	---	---	---	---
Hawaii	89	11	---	---	---	---
Puerto Rico	80	20	---	---	---	---
Florida	---	100	---	---	---	---
Others	43	57	---	---	---	---

[1/] Each sample was 80 grams of molasses, diluted with water. Precipitate was measured after standing overnight.

Table 6.--Range of prices paid for molasses by feed manufacturers located at various distances from a Gulf Coast port, Texas, 1957-58

Period	Number of samples	Distance from port	Price or range of prices per ton
		Miles	Dollars
Oct. - Nov. 1957	4	0	25.86
	1	100	27.58
	7	300	22.66 - 34.20
	4	600	30.78 - 46.80
Dec. 1957 - Mar. 1958	12	0	23.50 - 24.14
	2	100	29.84 - 30.95
	9	300	23.94 - 31.90
Apr. - Aug. 1958	68	0	27.58 - 28.79
	14	200	19.54 - 33.36
	42	300	26.25 - 35.06
	10	500	30.00 - 41.37

the highest price was paid at distances of 300 to 600 miles from the port. In many instances variations in price were not associated with distance from port or point of production, however.

Practically no relationship was found between the price and the feeding quality of molasses as measured by percentage of total sugar or moisture, or degrees Brix. Although carbohydrates represent the greatest nutritive value in molasses, feed users do consider physical properties, which may not be found in other livestock feeds, in the overall evaluation of molasses as a feed ingredient. These include binding and dust settling qualities, taste, and aroma.

Comparison of Cost of Carbohydrates

The cost of a ton of carbohydrate was calculated for molasses containing different percentages of total sugar and selling for $26.00 and $30.00 per ton. The cost of a ton of carbohydrate from corn selling at $2.20 per 100 pounds is given for comparison. When molasses sells for $26.00 per ton and contains 43 percent total sugar, a ton of carbohydrate costs $60.45. When the molasses contains 55 percent sugar and sells at the same price, a ton of carbohydrate costs $47.27. Thus a ton of carbohydrate costs $13.18 more when the molasses contains 43 percent sugar instead of 57 percent. Costs of 1 ton of carbohydrate from molasses containing different percentages of sugar are given in table 7.

Table 7.--Molasses containing different percentages of sugar: Quantity required to give 1 ton of carbohydrate, and cost of carbohydrate, Texas, 1958 1/

Total sugar content	Quantity of molasses required to give 1 ton of carbohydrate	Cost of a ton of carbohydrate when a ton of molasses sells for-- $26.00	$30.00
Percent	Pounds	Dollars	Dollars
43	4,650	60.45	69.75
45	4,444	55.30	66.66
47	4,255	55.30	63.84
49	4,082	53.06	61.23
51	3,922	51.00	58.83
53	3,773	49.10	56.58
55	3,636	47.27	54.54
57	3,490	45.37	52.35

1/ Pounds of corn required for 1 ton carbohydrate = 2,886. Cost of 1 ton carbohydrate from corn at $2.20 per 100 lb. = $64.10.

RECOMMENDED ANALYSES TO BE USED FOR GRADING MOLASSES

Brix.--In the past, degrees Brix has often been the only measure used to evaluate the quality of blackstrap molasses. This unit was included in the tentative definition for feeding cane molasses given in the official publication of the Association of the American Feed Control Officials, Inc., for 1958: "Feeding Cane Molasses is a product prepared from the juice of sugar cane. It may consist of various types of cane molasses or blends thereof with or without addition of other constituents which are normally present in and derived from cane molasses, provided the total sugar content expressed as invert sugar is not less than 48 percent and the Brix, by double dilution, is not less than 79.5°." Even though Feed Control officials have specified the amount of sugar that must be present, few analyses were made for sugar.

The wide variation in moisture and sugar contents of molasses with the same degrees Brix is illustrated in table 8. For example, in 9 samples with 78.8 degrees Brix, the moisture content ranged from 23.9 to 29.7 percent and sugar content ranged from 43.5 to 52.0 percent. In general, the variation was less in molasses with a high Brix.

Table 8.--Range of moisture and sugar found in molasses at various degrees Brix, Texas, 1958

Number of samples	Brix	Range	
		Moisture	Sugar
	Degrees	Percent	Percent
9	78.8	23.9 - 29.7	43.5 - 52.0
14	79.1	23.8 - 27.7	47.2 - 52.6
6	79.5	22.9 - 27.5	49.2 - 54.8
3	81.2	24.0 - 28.8	45.7 - 52.9
3	88.4	21.2 - 21.8	52.8 - 56.1
5	93.2	16.5 - 18.1	54.8 - 58.1
2	94.2	17.2 - 17.6	52.4 - 56.0

The correlation coefficients between various constituents in blackstrap molasses, for all of the samples, and between price and certain characteristics for Feed Control samples, are:

	Correlation coefficient
All samples:	
Brix vs. sugar	0.510
Moisture vs. sugar	.600
Ash vs. sugar	.066
Brix vs. protein	.035
Brix vs. viscosity	.500
Viscosity vs. sugar	.035
Moisture vs. viscosity	.582
Feed Control samples:	
Sugar vs. price	.068
Moisture vs. price	.119
Brix vs. price	.064
Distance from port vs. price	.326

The correlation between price and any constituent was low. When all samples were used, the correlation between moisture and sugar was higher than for other constituents. Since the correlation between Brix and sugar is low, and the correlation between Brix and price is nil, this unit has practically no value as a measure of the quality of molasses.

Bioassay of Nutrients in Molasses

In order to make recommendations of the factors to be considered for determining grades or standards for molasses, it was necessary to determine the nutrients present. The logical procedure for determining these nutrients was by biological assay. Biological assays were run with chicks as the assay animal, although molasses is not normally used in chick diets. However, to determine the individual nutrients in any food by bioassay, it is necessary to use an animal that requires the specific nutrients that are being determined. Because chicks require a larger number of known nutrients than most animals used for bioassays, they are ideal for determining the nutrients and amounts present in any food.

The addition of 10 percent of molasses to the diet showed that molasses supplied practically no calcium, vitamin A, thiamine, riboflavin, or pantothenic acid. It supplied small amounts of choline and pyridoxine at a 10 percent level and an adequate amount of pyridoxine at a level of 20 percent.

Ash.--An assay for iron, copper, cobalt, and manganese using chicks showed that manganese was the only necessary trace mineral supplied by molasses. Nutritionists generally recognize that diets composed of natural foodstuffs supply adequate trace minerals except in areas where a specific trace mineral deficiency is known to exist. In these areas, the mineral is usually added to animal feeds as an inorganic salt of the deficient mineral. Under most practical feeding conditions, the ash of molasses would be relatively unimportant nutritionally, but it has a laxative effect. If the molasses used is excessively high in ash and a large quantity is added to the diet, a diarrhea may result. The feces of chicks receiving 10 percent molasses were wet, and those of chicks receiving 20 percent were practically liquid.

Protein.--Molasses normally supplies a small amount of protein, but since it is questionable whether the protein is digestible, inclusion of this nutrient in a grade or standard based on nutritional value would not serve any useful purpose.

Carbohydrate.--Assays with chicks showed that carbohydrates was by far the most important nutrient in molasses. Molasses is used principally in cattle feeds and in horse and mule feeds, and more information about the fundamental nutritional requirements of these animals will have to be obtained before it can be determined whether molasses supplies any nutrient other than carbohydrate. The carbohydrate in molasses is a large source of energy. The most economical use of molasses in livestock feeds is probably for ruminants, where the sugar in the molasses furnishes direct energy as well as energy for the micro-organisms in the rumen to make the nutrients in the relatively non-digestible crude fiber available to the animal. Because of the nutritional value of the carbohydrate this constituent should definitely be used in any grade or standard for molasses.

Moisture.--Some molasses is high in both moisture and carbohydrate. Such molasses would be essentially equivalent in nutritive value to another lot that was low in moisture and contained the same amount of carbohydrate as the first lot. However, the first lot would be less desirable for mixing in feeds because the extra moisture in the molasses increases the possibility that the feed mixture will heat and spoil. Investigations which have been carried out on feed spoilage at the Texas Agricultural Experiment Station during the past 5 years have shown repeatedly that feeds containing molasses high in moisture are more likely to mold and heat than those containing molasses low in moisture. That this spoilage is due to the water in molasses, rather than to a specific property of the molasses, was demonstrated by the addition of the same amount of water to the mixtures as that in the molasses. The water caused the mixture to heat just as rapidly as the molasses, and it was the only component responsible for the spontaneous heating and spoilage.

If the cereal grains and other ingredients in the mixture were low enough in moisture, it might be possible to use molasses containing 27 to 30 percent moisture without spoilage. However, with the moisture standards now acceptable for grains, it is practically impossible to mix feeds with molasses containing 27 to 30 percent moisture without spoilage. Because of the effect of other ingredients in the mixture, standards for the moisture content of molasses will not guarantee the absence of spoilage; but the moisture content of molasses should be 26 percent or lower to reduce spoilage to a minimum.

Since carbohydrate (total sugar) is the only important nutrient in molasses, and since water is a major cause of spontaneous heating and spoilage in mixed feeds, it appears that these two constituents are the only ones necessary to include in grades or standards for feeding molasses.

The distribution chart for sugar in figure 1 shows that the Feed Control samples fall into three groups. One group contains 43 to 48 percent sugar, the second and largest group contains 49 to 53 percent sugar, and the third contains 54 to 60 percent sugar. The distribution chart for moisture in figure 1 shows that approximately one-third of the molasses distributed in Texas for feeding purposes contained 27 percent or more moisture. Feeds mixed with molasses this high in moisture would be highly susceptible to mold growth and the accompanying heating and spoilage.

One to 4 percent less water would not have increased the difficulty in handling the molasses and it would have decreased the susceptibility of feeds to spoilage. It would, also, have decreased the proportion of molasses containing 48 percent or less sugar from 15 to slightly less than 9 percent of the samples.

With carbohydrate and water as a basis for marketing molasses, the user could pay a higher price for molasses high in carbohydrate and low in water than for that which is low in carbohydrate and high in water. With a known amount of carbohydrate he would receive a known amount of energy for his feeds, and he would save the expense of transporting water.

RECOMMENDATIONS FOR GRADING AND LABELING

On the basis of analysis of samples collected in this study and the critical nature of moisture in mixed feeds, the following recommendations should be considered in establishing grades and standards for molasses:

(1) Limit the term "blackstrap" specifically to the byproduct produced in sugarcane refining.

(2) Use water and total sugar as a basis for grades of molasses from any source.

(3) Establish three grades of blackstrap for feeding molasses:

(a) Superior Blackstrap Molasses--cane molasses containing 23.4 percent or less water and 53.5 percent or more total sugar.

(b) Blackstrap Molasses--cane molasses containing 23.5 to 26.4 percent water and 48.5 to 53.4 percent total sugar.

(c) Utility Blackstrap--cane molasses containing 26.5 percent or more water and 42.5 to 48.4 percent total sugar (with the exception of one sample which obviously was not cane molasses, no molasses entering the Gulf Coast area would contain less than 45 percent sugar when diluted to contain from 24 to 26 percent water).

(4) Label mixtures normally sold as feed molasses containing blackstrap and one or more other products, or containing less than 42.5 percent total sugar, to identify the sources, and the moisture and total sugar present.

(5) Label molasses distributed for livestock feed from sources other than cane, such as beets, milo, or citrus, to identify the source, the brand name for that source, and the amount of water and total sugar present.

APPENDIX: METHODS OF ANALYSES

The methods used for analyses of various constituents in the molasses were essentially the same as those described by the Association of Official Agricultural Chemists (AOAC). 4/

The procedures used are outlined briefly as follows:

Determination of Total Invert Sugar

(1) Weigh approximately 10 gm. of a thoroughly mixed molasses sample directly into a 250-ml. volumetric flask.

(2) Add approximately 200 ml. of water and swirl until the molasses is suspended. Ten ml. of a saturated solution of neutral lead acetate is added to precipitate the protein. Make to volume and filter through Whatman No. 1 filter paper.

(3) Remove the excess lead from a 50-ml. aliquot of the clarified filtrate by addition of anhydrous potassium oxalate. The oxalate is added in small quantities until the test for lead is negative. Make to 200-ml. volume and filter through Whatman No. 50 filter paper.

(4) Inversion: Pipet 50 ml. of lead-free filtrate into a 100-ml. volumetric flask containing 25 ml. of water and 10 ml. of HCl (1:1 Conc. HCl:water) and allow to stand at room temperature for 10 hours. Neutralize with 6N NaOH and dilute to 100 ml.

(5) Reduction of copper: Transfer 25 ml. of each of the copper sulfate and alkaline tartrate solutions to a 400-ml. beaker and add 50 ml. of the reducing sugar solutions. Heat the beaker on an electric heater at a setting that will cause the solution to boil in 4 minutes. Continue boiling for 2 minutes. Glass beads are added to prevent bumping and the beaker is covered with a watch glass during heating. Filter the hot solution through a 30-ml. crucible with a fritted disk of medium porosity. Wash the precipitate with water at 60° C. and determine the quantity of reduced Cu by the titration procedure.

(6) Transfer the fritted crucible containing the Cu_2O to the 400 ml. beaker and add 50 ml. of ferric sulfate solution and 20 ml. of 4N H_2SO_4. Stir vigorously until the Cu_2O is dissolved. Remove the crucible from the beaker and wash the outside thoroughly allowing the washings to flow into the beaker

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4/ Association of Official Agricultural Chemists. Official and Tentative Methods of Analysis. 8th ed. Washington 4, D. C. 1955.

with the ferric sulfate solution. Pour the solution through the fritted crucible using suction and wash the beaker thoroughly adding the washings to the filtrate. Titrate the solution with standard potassium permanganate (about 0.1575 N). As the end point approaches, add 1 drop of the ferrous phenanthroline indicator. At the end point, the brownish solution changes to green. The weight of reducing sugar equivalent to the weight of copper was ascertained from table 42.12 AOAC.

Determination of Moisture

Weigh 2-5 gm. of thoroughly mixed sample in a flat aluminum dish with tight-fitting cover and dry in a vacuum oven 8 hours or overnight or to constant weight at a temperature not to exceed 60° and at a pressure not to exceed 30 mg. Hg. The oven is bled with a current of dry air for first 15-20 minutes to remove H_2O vapor. After 18 hours the dried samples are removed, cooled and weighed.

Determination of Brix

Weigh out 80 gm. of a thoroughly mixed sample and add 80, 100, or 120 gm. of water into a 400-ml. beaker. Heavy samples require 100 or 120 gm. of water to insure a Brix in the range for which the hydrometer was graduated. Mix thoroughly and transfer to a tube large enough to permit the spindle of the hydrometer to come to rest without touching the sides. Allow to stand for 5 to 10 minutes and read degrees Brix and temperature. Use AOAC temperature corrections.

Determination of Protein

Place weighed sample (0.7-2.2 gm.) in a digestion flask. Add 25 ml. of conc. H_2SO_4 and a mercury pack containing 0.65 gm. metallic Hg, 15 gm. powdered K_2SO_4 or anhyd Na_2SO_4. If a sample larger than 2.2 gm. is used, increase H_2SO_4 10 ml. for each gram of sample. Place flask in an inclined position and heat gently until frothing ceases. Boil briskly until solution clears and then for at least 30 minutes longer.

Cool, add about 250 ml. H_2O, cool below 25° C., then add 25 ml. of the sulfide or thiosulfate solution and mix to precipitate the mercury. Add a few Zn granules to prevent bumping. Tilt the flask and add 110 ml. of strong NaOH without agitation. Immediately connect flask to distilling bulb on condenser and with the tip of the condenser immersed in 15 ml. of standardized acid solution and about 50 ml. of water. Rotate the flask to mix contents thoroughly, then heat until all the NH_3 has distilled over (at least 150 ml. distillate). Titrate the standard acid in the distillate with standard alkali using methyl red as indicator.

Determination of Ash

Weigh 4.5-5.5 gm. of a thoroughly mixed molasses sample. Add a few drops of olive oil and heat slowly over a flame until swelling ceases. Place the dish in a muffle furnace at about 525° C. and leave for 10-20 hours. The dish is removed, cooled and weighed.

Determination of Relative Viscosity

Modified Ostwald-Fenske viscosimeter tubes, 400 and 500 ASTM sizes, were used to determine the relative viscosity of the molasses samples at 50° C. The method of loading and determining efflux time was essentially the same as described by Cannon and Fenske, Ind. and Eng. Chem., Vol. 10, No. 6, Analytical Edition. A 400 ASTM modified Ostwald-Fenske viscosimeter with a National Bureau of Standards certificate was used to calculate the factor for the viscosimeter tubes used to determine the viscosity of the molasses samples.

Determination of Foreign Matter

Foreign matter is determined by diluting 200 gm. of molasses with an equal weight of water. The mixture is passed through a crucible fitted with a coarse sintered glass disk. The residue left on the glass disk is described as either negligible, present, or excess amount.

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centi-stokes	Percent
Bureau of Customs:						
Cuba:						
15	20.3	7.6	85.0	59.4	1,516	2.5
23	20.8	8.2	86.2	57.9	1,263	3.0
28	19.6	10.5	88.4	55.7	1,523	4.0
30	19.6	10.5	88.4	53.9	1,607	4.0
45	21.3	7.5	84.4	56.1	862	2.6
46	18.9	7.5	86.8	56.6	2,249	3.7
91	19.8	8.1	86.5	53.1	622	3.8
152	20.0	9.2	84.8	55.5	1,283	3.4
184	21.0	9.9	86.0	54.2	907	2.9
195	17.4	9.8	87.5	57.3	3,499	3.5
205	20.3	9.3	87.8	55.6	1,137	2.9
206	19.3	9.1	87.6	55.5	1,438	3.1
213	18.3	8.0	88.3	58.7	2,466	3.0
224	17.6	9.1	89.0	57.2	2,965	3.3
231	18.0	8.5	87.9	56.7	2,447	3.8
234	18.5	9.6	88.8	56.1	2,845	3.3
261	20.0	9.5	95.3	55.5	844	---
262	16.9	10.3	89.9	57.5	2,346	---
263	17.7	9.1	88.3	58.2	2,313	---
270	17.6	8.3	88.0	58.7	2,173	---
271	16.3	10.3	90.6	54.6	4,128	4.7
278	17.4	9.8	88.7	58.2	2,650	---
307	18.3	6.7	84.9	61.3	1,112	---
308	17.8	7.4	86.4	57.8	2,145	---
309	18.2	6.8	86.6	60.8	2,022	---
319	17.8	7.7	86.0	57.8	1,827	3.2
335	20.1	8.1	84.5	56.3	505	---
Other foreign areas: 1/						
138	24.0	20.6	80.9	17.3	125	20.0
133	16.5	7.6	89.6	59.6	4,737	3.9
147	17.2	8.3	89.6	60.2	3,078	2.3

--Continued

1/ Dominican Republic, Ecuador, Jamaica, and Netherlands.

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centi-stokes	Percent
Bureau of Customs (Cont.):						
Other foreign areas (Cont.):						
146	18.9	7.6	87.2	60.6	1,659	1.6
Mexico:						
7	18.0	13.3	92.3	55.5	1,627	2.4
8	23.6	11.8	85.0	48.8	396	1.3
9	23.5	11.8	84.3	49.4	2,320	1.2
10	16.4	14.3	93.4	55.7	436	2.0
22	18.0	9.6	89.7	57.8	2,443	2.7
24	18.3	9.4	89.6	59.2	2,041	2.6
25	18.0	9.6	89.3	58.7	2,249	2.7
26	21.0	12.8	87.4	54.4	685	3.1
27	23.4	8.8	83.5	55.4	389	1.7
49	16.9	13.2	92.6	54.9	2,249	2.3
50	17.6	13.0	92.4	54.6	2,041	---
55	17.4	13.1	92.8	54.7	1,925	---
57	17.1	12.2	93.0	55.8	2,287	---
58	18.7	12.9	90.8	55.7	377	---
59	28.3	11.2	80.1	45.6	116	2.0
60	18.4	13.1	90.9	55.9	1,107	---
61	16.8	13.8	87.1	57.8	2,300	---
62	20.9	10.2	87.4	56.4	751	---
63	22.7	11.4	86.3	49.1	442	---
64	16.4	13.6	93.9	56.2	2,346	2.0
65	18.8	12.7	91.1	55.9	1,147	---
66	18.6	13.1	91.1	55.8	2,125	---
67	20.5	11.1	88.3	52.7	855	---
68	16.5	13.4	92.6	57.1	2,527	---
69	16.8	13.5	93.5	56.3	2,054	2.1
71	17.1	13.5	92.7	56.5	2,275	---
72	16.8	13.3	93.2	56.3	2,352	---
73	17.7	12.9	92.9	56.4	1,989	2.0
75	17.3	13.2	92.6	56.2	2,521	---
76	17.2	13.1	92.4	56.0	2,404	2.1
77	17.3	13.1	92.4	55.9	2,177	2.1

--Continued

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centi-stokes	Percent
Bureau of Customs (Cont.):						
Mexico:						
78	17.3	13.3	92.4	55.1	2,125	2.3
80	17.8	12.7	91.2	55.7	1,711	2.3
81	17.4	12.8	92.1	56.2	2,151	2.4
94	17.3	13.3	92.9	55.7	2,028	2.1
96	17.1	13.6	92.7	54.8	1,737	---
97	16.9	13.4	92.8	56.6	2,339	---
98	17.2	13.2	92.7	56.6	2,216	---
99	17.2	13.4	86.4	54.6	1,821	---
100	17.2	13.4	92.3	55.0	1,963	2.1
101	25.3	12.2	84.0	49.2	197	---
102	22.0	10.9	86.4	50.5	680	---
103	20.6	11.7	89.0	50.7	842	---
104	23.8	11.1	85.6	48.7	348	---
105	25.2	11.5	87.5	47.8	232	1.8
118	17.9	12.4	92.9	54.4	1,724	---
123	18.3	12.1	91.7	55.3	1,458	---
126	17.1	12.8	93.2	58.0	2,229	---
127	17.3	12.6	93.2	58.1	2,067	---
128	17.1	13.4	93.1	56.1	2,359	2.3
129	21.8	11.3	88.4	52.8	998	---
130	25.7	10.6	83.9	47.9	265	---
131	16.5	12.8	93.2	58.0	2,054	---
135	23.7	10.3	84.0	51.3	397	---
137	17.5	10.0	78.8	56.2	2,592	2.0
139	18.9	14.2	92.0	53.0	1,212	---
140	18.8	14.0	92.1	53.3	1,179	---
141	21.8	12.6	87.4	52.1	409	---
142	16.5	13.6	94.3	57.7	2,547	---
143	18.1	13.8	93.9	57.1	1,918	2.1
144	21.9	12.7	88.6	52.3	461	---
145	21.9	12.7	87.4	50.7	466	---
149	24.1	10.4	84.0	51.4	441	---
150	17.9	13.0	93.0	54.2	1,789	---
153	22.9	12.0	86.7	54.3	280	1.4
154	24.0	11.5	86.5	50.2	531	---
155	17.6	14.0	94.2	56.0	2,385	---
156	22.0	11.0	88.2	52.9	1,367	---

--Continued

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Percent
Bureau of Customs (Cont.):						
Mexico:						
157	15.6	15.8	94.9	56.0	3,707	---
159	16.7	13.1	93.0	56.5	2,229	3.1
161	17.1	13.1	92.7	57.0	2,262	---
162	17.0	13.4	93.1	56.5	2,352	---
163	16.5	13.1	93.1	56.3	2,339	---
164	16.9	13.3	93.0	55.8	2,398	---
176	17.5	13.9	92.6	54.1	2,190	2.6
177	17.2	14.9	94.2	52.4	2,352	---
178	16.3	14.9	93.9	53.5	3,112	---
179	16.0	14.7	93.7	54.1	4,180	---
180	15.5	15.0	89.6	54.0	6,428	---
182	17.8	15.0	92.8	53.0	1,983	2.2
183	17.4	14.4	94.0	54.1	2,320	---
185	17.3	14.4	93.4	54.4	2,268	---
186	14.8	15.2	89.3	56.3	7,112	---
187	18.0	14.6	92.3	55.2	1,698	---
189	17.0	15.2	93.1	53.7	2,637	2.1
190	16.4	15.0	93.4	55.0	3,720	---
193	17.3	15.0	92.5	54.0	2,518	---
194	18.5	10.4	89.1	57.9	1,302	---
196	17.6	13.9	92.5	55.0	1,944	---
197	23.7	12.6	86.4	53.8	231	1.5
198	22.3	12.7	88.2	55.0	452	---
199	23.5	11.8	86.4	52.8	479	---
200	17.7	14.9	93.0	54.0	2,100	---
201	24.4	12.5	86.6	53.5	246	---
202	23.8	11.0	85.2	50.9	499	1.6
203	25.1	10.6	84.1	49.3	399	---
204	22.3	12.7	88.1	53.7	396	---
207	17.2	13.1	91.7	54.3	2,113	---
208	16.9	13.7	92.7	55.1	2,300	---
209	17.2	13.2	91.9	54.9	2,000	3.3
211	17.0	13.3	92.8	55.1	2,365	---
212	17.5	13.0	92.5	54.5	1,639	---
214	22.4	11.8	87.3	54.6	377	---
215	25.5	11.0	82.5	48.5	212	---
216	22.2	12.6	88.0	54.0	348	1.6

--Continued

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Percent
Bureau of Customs (Cont.):						
Mexico:						
217	25.3	11.5	83.0	49.6	233	---
218	24.5	11.5	83.9	48.9	321	---
219	21.3	12.7	87.8	54.8	748	---
220	20.6	12.8	88.9	55.2	459	---
221	19.7	11.6	87.7	54.4	862	2.1
222	25.1	11.6	83.2	49.7	215	---
225	16.6	13.4	93.0	54.7	2,190	---
226	17.8	14.8	93.6	51.9	1,955	---
227	16.0	15.0	95.4	54.0	3,895	---
228	18.3	15.0	93.6	50.8	1,968	2.3
229	17.6	14.3	93.6	52.9	2,177	---
230	17.7	14.3	94.0	52.7	1,987	---
237	15.8	16.0	95.1	53.4	1,968	---
238	22.7	13.5	86.2	51.2	235	---
239	20.0	12.7	89.2	55.4	502	1.6
240	20.3	12.2	88.5	56.4	553	---
241	21.7	12.5	86.9	54.0	335	---
242	21.0	12.2	87.8	54.7	399	---
243	22.5	13.3	86.9	52.4	268	---
244	21.7	12.2	88.0	55.3	378	1.6
245	22.0	16.1	86.9	55.8	408	---
246	22.7	14.6	85.5	50.8	26.7	---
247	14.9	16.4	96.8	55.4	3,208	---
248	24.9	11.7	83.0	49.9	216	---
249	21.5	11.7	88.2	55.2	428	1.6
250	21.5	12.0	88.6	55.6	474	---
251	21.2	12.4	88.4	55.4	424	---
252	22.2	13.5	87.5	52.9	266	---
253	18.3	12.8	94.4	52.5	1,093	---
254	16.6	13.5	93.4	55.8	2,320	2.9
255	18.6	12.9	90.9	53.8	1,004	---
256	19.0	13.2	90.6	52.9	946	---
264	18.3	13.2	90.5	54.0	829	---
265	18.5	12.9	89.9	53.9	914	---
266	18.6	13.6	90.6	54.4	946	3.5
268	18.8	13.1	90.0	54.3	888	---
269	16.7	14.3	93.2	55.8	2,015	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Percent
Bureau of Customs (Cont.):						
Mexico:						
273	15.8	15.3	94.9	54.0	3,110	---
277	15.2	15.3	94.9	54.2	3,981	---
281	17.2	14.8	94.2	54.6	2,064	2.7
282	16.2	15.2	95.4	54.4	2,961	---
283	16.0	15.5	95.6	55.3	3,169	---
284	16.1	15.3	95.6	54.5	2,605	---
291	18.1	13.9	93.2	54.8	1,252	---
292	19.0	14.0	92.5	54.4	1,290	2.9
293	21.1	11.2	88.0	56.7	513	---
294	24.7	10.6	83.1	52.0	230	---
295	22.6	12.7	86.9	54.3	273	---
296	21.6	11.2	87.8	56.4	479	---
297	16.7	10.1	90.2	55.4	2,735	2.6
304	18.7	12.9	90.4	54.3	1,024	---
305	18.3	13.1	89.9	54.7	952	---
311	18.2	12.8	91.1	52.9	1,068	---
312	16.1	15.1	96.0	53.8	2,689	2.8
313	16.2	14.5	94.6	54.3	2,409	---
314	16.3	15.2	95.1	54.3	2,435	---
315	16.1	16.0	95.5	54.0	2,469	---
316	15.6	14.9	95.6	54.7	2,942	---
323	22.7	10.7	86.0	51.7	505	---
324	20.7	11.8	87.8	51.8	777	---
325	20.3	11.3	87.6	52.0	739	---
326	18.7	12.0	89.2	55.7	763	---
327	19.8	11.7	86.8	57.2	550	1.7
328	20.5	11.7	87.4	52.0	726	---
329	21.4	13.1	86.6	51.3	305	---
330	16.3	13.9	91.9	52.0	1,341	---
331	16.7	15.7	91.8	51.5	812	---
332	18.8	12.7	87.8	50.7	525	2.4
333	15.1	15.4	94.6	53.6	1,719	---
336	18.4	11.4	88.8	55.8	1,093	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Percent
Texas Feed Control Service:						
Cane (blackstrap) delivered to consumers:						
2	25.8	7.1	78.9	51.0	250	2.4
3	27.0	8.5	79.3	47.7	211	3.6
4	25.8	7.0	79.1	50.8	261	2.4
5	27.6	8.4	77.8	46.7	425	3.0
6	27.8	11.6	79.8	47.0	116	1.7
11	26.3	8.4	79.3	50.7	227	2.2
12	27.7	10.5	79.1	47.2	143	2.3
13	31.2	10.0	75.0	44.4	89	2.4
14	26.9	8.4	79.4	50.4	193	4.1
17	26.7	9.5	79.4	51.1	297	3.2
18	28.5	9.5	77.8	49.0	169	2.3
19	26.0	8.0	79.2	49.6	274	2.7
20	26.3	8.1	79.8	51.7	207	3.0
21	24.6	8.4	81.2	53.5	390	3.0
29	26.7	9.3	79.6	49.7	244	3.5
30	19.6	10.5	88.4	53.9	1,607	4.0
39	27.0	8.9	79.4	50.2	216	3.5
40	27.2	9.6	79.2	50.3	290	3.5
41	27.5	9.3	78.8	49.1	153	2.6
47	29.2	8.9	78.7	47.8	98	2.1
48	27.1	11.4	82.7	48.6	146	---
51	26.9	9.1	79.9	48.6	224	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity 50°	Viscosity 60°	Protein
	Percent	Percent	Degrees	Percent	Centistokes		Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
52	27.6	9.2	78.7	48.7	145	---	---
53	27.1	8.6	78.9	49.2	185	---	---
54	22.0	8.4	84.5	53.9	875	---	---
56	27.1	8.6	78.8	48.4	194	---	3.0
74	21.3	7.9	84.1	54.5	1,043	---	---
79	25.1	7.4	80.2	51.5	348	---	---
93	23.8	8.0	79.1	51.4	184	---	---
95	22.4	7.8	78.9	51.3	237	---	---
117	24.4	7.7	79.1	51.9	185	---	---
119	19.7	8.9	87.4	54.8	1,296	---	3.2
121	24.4	7.7	78.7	52.4	188	---	---
122	24.6	7.9	79.2	50.6	166	---	---
125	26.5	7.8	79.1	52.3	194	---	---
132	26.6	8.6	80.1	49.5	223	---	3.0
136	26.5	8.4	89.8	50.6	178	---	---
148	27.5	8.7	79.5	50.6	166	---	---
151	27.1	8.8	79.7	49.8	165	---	---
160	20.7	9.7	86.9	55.0	920	---	---
166	26.5	8.1	79.7	52.1	200	---	2.1
167	26.7	8.0	79.6	51.5	185	---	---
181	27.3	9.0	79.0	50.1	185	---	---
188	26.3	8.5	79.6	49.9	181	---	---
191	26.9	9.6	79.3	49.2	174	---	2.5
210	26.9	8.9	79.0	48.8	192	---	---
223	26.1	9.0	80.6	49.1	175	---	---
232	26.7	9.0	80.1	49.0	159	---	---
233	22.2	9.0	84.2	52.2	716	---	4.6
235	28.8	12.2	81.2	45.7	81	---	---
236	26.8	9.0	79.2	49.0	162	---	---
257	26.7	8.8	79.3	49.0	167	4,931	---
258	26.6	8.7	79.3	48.8	176	6,545	---
259	26.2	8.1	78.5	49.6	150	5,981	---
267	25.9	9.1	80.3	49.3	191	6,104	---
272	29.0	9.3	76.6	47.9	116	2,547	---
274	27.2	8.4	78.4	49.3	152	3,778	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses and sample number	H_2O	Ash	Brix	Sugar	Viscosity 50°	Viscosity 60°	Protein
	Percent	Percent	Degrees	Percent	Centistokes		Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
275	27.1	9.3	78.8	49.2	176	4,914	---
276	27.1	9.4	79.0	49.0	170	4,818	2.6
279	27.1	8.7	78.6	49.5	180	6,626	---
280	27.3	8.7	78.4	50.0	189	5,955	---
285	30.3	8.8	74.4	45.8	119	2,722	---
286	24.8	6.4	79.4	54.2	295	14,483	---
287	27.3	8.7	79.0	49.7	186	6,441	4.1
288	17.8	6.6	87.3	59.6	3,240	50,000	---
289	27.4	8.8	79.0	49.4	169	5,469	---
290	27.7	9.5	78.8	48.7	188	4,815	---
299	24.3	6.7	79.5	54.8	336	14,198	4.0
300	26.8	9.6	78.7	49.4	187	6,211	---
301	25.1	5.7	79.6	55.7	269	13,647	---
303	29.7	12.0	78.8	43.5	92	1,725	---
306	23.8	6.1	79.7	55.0	289	13,802	
310	22.2	13.1	84.0	51.8	607	45,056	4.5
318	18.0	6.7	86.4	58.9	2,530	50,000	---
320	23.5	6.9	79.5	53.0	243	12,473	---
322	25.2	8.9	79.4	49.2	176	---	4.0
334	19.2	10.1	85.2	52.6	818	45,000	---
337	26.2	9.1	79.0	48.4	186	6,188	---
338	26.9	9.2	78.9	48.6	195	6,390	
339	24.8	7.5	77.0	47.7	129	3,396	---
340	25.5	9.0	78.0	47.0	150	4,399	3.1
341	22.9	7.6	79.5	52.8	250	9,727	---
342	23.7	7.3	78.4	50.4	220	6,305	---
343	20.0	7.0	81.6	55.3	515	27,702	---
344	18.7	8.5	84.5	53.8	804	50,000	---
345	18.5	8.3	84.4	54.0	907	50,000	3.7
346	22.4	7.3	79.6	53.2	264	10,219	---
347	28.3	12.6	79.8	44.9	75	1,502	---
348	24.6	7.2	79.2	53.3	254	9,080	---
351	24.6	7.1	79.4	53.2	243	9,087	---
352	24.6	7.3	79.2	51.8	260	9,841	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses and sample number	H_2O	Ash	Brix	Sugar	Viscosity		Protein
					50°	60°	
	Percent	Percent	Degrees	Percent	Centistokes		Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
353	2/	---	---	---	---	---	---
354	23.9	7.4	80.2	52.2	243	9,228	---
355	2/	---	---	---	---	---	---
356	23.5	7.1	79.4	52.2	250	9,312	---
357	23.8	7.5	79.8	51.9	266	9,390	2.9
358	24.6	7.8	78.7	50.7	223	7,776	---
359	24.2	6.9	79.4	52.9	258	9,927	---
360	24.3	7.1	79.3	53.5	240	9,286	---
361	25.3	8.1	78.9	49.7	215	7,705	---
362	24.1	7.4	79.6	52.2	276	9,623	3.3
363	24.2	8.7	80.5	51.7	213	6,804	---
364	22.7	8.3	79.4	49.9	336	17,490	---
365	24.1	8.1	78.9	50.6	256	9,040	---
366	24.6	7.7	78.8	50.7	221	7,426	---
367	25.6	8.2	79.2	50.3	216	6,137	3.4
368	25.0	8.3	79.0	49.6	224	8,387	---
369	24.3	7.6	79.1	49.8	210	5,411	---
370	25.7	9.0	78.3	46.2	173	8,931	---
371	24.5	7.8	79.2	52.9	217	8,839	---
372	25.3	8.2	78.6	51.7	219	7,238	3.3
373	24.4	7.6	79.2	52.9	230	9,600	---
374	25.0	8.5	79.0	51.2	193	6,046	---
375	24.4	7.7	79.1	51.4	229	8,094	---
376	24.0	7.6	78.9	53.6	233	8,956	---
377	26.1	9.9	78.9	49.4	137	3,162	2.2
378	24.6	7.6	79.4	52.9	247	9,885	---
380	24.0	7.5	79.0	53.9	253	9,174	---
381	26.7	8.4	78.8	51.1	211	6,746	---
382	25.5	7.5	78.0	50.3	188	5,725	3.5
384	24.1	8.6	79.9	50.6	220	6,785	---
385	25.9	8.8	78.4	49.9	190	6,185	---
386	26.9	9.1	79.0	48.1	155	3,872	
387	25.7	8.5	77.6	50.5	163	4,607	1.8

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2/ Lost in shipment.

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses and sample number	H_2O	Ash	Brix	Sugar	Viscosity 50°	Viscosity 60°	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Centistokes	Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
389	27.0	8.3	77.5	48.3	178	4,905	---
390	22.9	5.7	78.6	53.5	179	7,731	---
391	24.9	7.3	79.1	52.5	241	9,584	---
392	25.0	6.7	78.4	52.3	279	11,969	---
393	24.6	7.2	80.0	53.0	263	10,582	2.8
394	24.3	7.1	79.3	53.1	261	8,158	---
395	24.5	7.6	79.3	52.1	260	10,973	---
396	24.9	7.6	79.6	50.4	231	8,780	---
397	25.8	7.6	78.4	51.4	202	6,068	---
398	24.4	7.8	79.4	51.1	250	9,908	3.4
399	24.8	7.7	79.4	51.2	221	7,782	---
400	25.1	7.9	79.2	50.9	226	9,199	---
401	25.6	9.2	79.5	49.2	240	7,198	---
402	26.3	7.4	77.6	50.3	173	4,147	---
403	26.3	9.4	78.3	48.1	202	5,365	2.6
404	25.2	7.5	78.4	49.3	200	8,245	---
405	26.9	7.5	77.8	46.1	157	3,285	---
406	27.1	9.8	77.4	46.4	173	3,946	---
407	23.5	7.0	79.4	50.0	193	8,663	---
408	27.7	8.4	77.2	46.7	171	4,951	3.0
409	26.6	9.1	78.3	48.3	186	6,026	---
410	24.4	7.5	79.2	52.0	238	---	---
411	23.9	7.7	79.8	53.6	257	---	---
412	24.7	7.6	79.4	52.3	231	---	---
413	24.0	7.4	79.5	52.8	260	---	2.6
414	23.9	7.4	79.2	53.0	314	---	---
415	24.0	7.3	79.3	53.0	316	---	---
416	24.8	7.5	79.2	50.5	265	---	---
417	24.9	7.4	79.1	50.9	249	---	---
418	26.8	9.1	77.4	47.3	160	---	---
419	24.3	7.2	79.7	52.4	276	---	---
420	25.8	8.2	79.1	49.4	222	---	---
421	24.9	8.7	79.2	49.2	192	---	---
422	24.7	7.4	79.2	51.1	250	---	---
423	26.6	11.7	80.7	48.8	109	---	2.2

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses and sample number	H_2O	Ash	Brix	Sugar	Viscosity		Protein
					50°	60°	
	Percent	Percent	Degrees	Percent	Centistokes		Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
424	24.6	7.8	79.6	52.3	210	---	---
425	26.8	9.4	77.8	46.6	181	---	---
429	23.4	7.5	79.7	53.7	264	---	---
430	25.3	7.5	77.4	50.7	180	---	---
431	23.9	7.4	78.8	51.1	243	---	2.9
432	23.7	7.5	79.3	51.5	244	---	---
433	23.2	7.6	79.8	54.5	329	---	---
434	24.5	7.3	78.4	51.5	188	---	---
435	25.2	9.0	78.2	48.3	159	---	---
437	25.4	7.3	79.1	52.6	298	---	---
438	25.6	7.3	79.0	51.9	236	---	---
439	25.2	7.3	79.4	50.7	240	---	---
440	24.1	7.4	80.2	53.8	253	---	---
441	27.2	8.6	78.3	48.7	207	---	3.5
442	24.4	8.0	80.0	51.8	233	---	---
443	25.2	7.9	79.1	52.3	239	---	---
444	29.7	8.7	75.5	45.8	109	---	---
445	27.6	9.3	78.3	48.5	186	---	---
447	24.6	8.0	79.9	52.1	278	---	---
448	23.7	8.3	80.5	51.6	326	---	---
449	25.7	8.1	78.9	50.6	187	---	---
450	26.0	9.0	81.0	47.6	221	---	---
451	24.9	9.2	79.2	50.0	223	---	3.5
452	24.4	7.5	79.2	51.8	215	---	---
453	26.4	8.2	78.0	48.6	179	---	---
454	24.8	7.9	79.7	51.0	262	---	---
455	24.9	9.2	79.0	51.7	242	---	---
456	23.7	9.2	80.1	53.5	353	---	2.3
457	24.9	9.2	79.1	51.1	233	---	---
458	23.9	8.3	79.8	53.0	338	---	---
459	23.8	8.4	79.2	50.8	263	---	---
460	25.2	6.6	77.8	51.3	217	---	---
461	24.8	7.4	78.9	50.5	233	---	2.8
462	24.0	7.5	79.8	53.0	334	---	---
463	24.2	7.6	78.8	52.0	250	---	---
464	24.0	7.2	81.2	52.9	346	---	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses and sample number	H_2O	Ash	Brix	Sugar	Viscosity 50°	Viscosity 60°	Protein
	Percent	Percent	Degrees	Percent	Centistokes		Percent
Texas Feed Control Service (Cont.):							
Cane (blackstrap) delivered to consumers (Cont.):							
465	26.8	9.2	77.6	47.2	172	---	---
466	24.4	7.9	79.1	52.3	275	---	2.6
467	26.9	8.3	76.6	48.4	172	---	---
468	26.7	12.7	80.1	48.0	104	---	---
469	29.4	10.5	76.7	49.6	92	---	---
Refinery:							
1	26.1	9.2	79.9	49.9	248	---	2.8
16	26.6	8.7	79.2	51.9	210	---	2.6
31	26.5	8.7	80.0	51.9	213	---	2.2
70	26.7	7.9	78.9	53.8	152	---	2.1
120	24.2	6.9	79.1	53.2	245	---	2.3
158	25.8	8.6	80.5	52.2	174	---	2.6
124	25.1	8.3	80.0	52.9	262	---	---
260	24.8	6.9	79.4	54.2	211	11,770	4.1
298	25.2	7.1	79.1	54.0	181	7,591	---
321	24.4	7.2	80.2	53.5	291	17,662	---
350	24.4	7.6	80.2	52.7	217	4,761	4.2
379	25.0	7.5	79.8	53.7	279	10,964	---
383	25.1	7.8	79.0	50.7	229	7,550	---
388	23.8	7.3	80.0	53.8	238	12,555	---
436	24.8	8.6	79.7	51.5	270	---	2.5
Milo molasses:							
192	22.6	2.9	77.4	52.2	105	---	---
317	19.9	2.0	76.9	53.4	99	5,605	---
349	22.2	7.0	77.2	53.6	91	10,467	---

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Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centistokes	Percent
Louisiana Department of Agriculture:						
Louisiana raw sugar mills:						
32	25.7	8.5	79.8	52.9	262	2.4
33	18.1	10.6	89.9	59.3	383	2.2
34	27.0	9.7	79.6	51.5	157	1.8
35	24.0	7.7	80:8	57.7	383	1.8
36	18.3	10.1	90.1	58.9	7,701	3.6
37	25.0	8.6	83.1	54.4	337	3.1
38	18.9	8.6	87.8	61.6	1,892	2.7
42	27.5	9.1	80.5	51.0	176	3.6
43	27.3	8.5	79.7	52.2	169	3.2
44	27.9	8.5	79.1	51.4	130	2.1
82	26.5	9.0	80.8	51.3	179	4.1
83	27.0	8.9	80.5	51.7	218	---
84	19.7	10.7	90.3	55.6	3,609	---
85	27.5	7.9	79.4	53.9	282	---
86	18.4	9.5	89.9	58.8	5,054	---
87	15.6	10.4	94.1	60.5	5,000	3.7
88	15.4	8.0	90.5	63.3	5,000	---
89	13.9	9.8	94.0	61.3	5,000	---
90	24.7	7.9	82.5	53.2	661	---
92	27.4	10.7	80.7	49.3	137	---
Hawaii:						
111	24.3	12.4	84.3	45.7	281	3.6
112	20.3	10.5	86.8	43.8	5,000	3.8
113	20.1	11.4	88.3	49.1	2,611	4.0
114	22.7	12.3	87.0	47.7	480	3.8
115	21.3	11.3	87.2	50.0	1,205	3.4
116	19.8	11.1	87.5	46.5	5,000	4.3
Puerto Rico:						
106	19.1	7.9	88.1	56.3	5,000	4.3
107	16.8	7.9	90.3	60.3	5,000	3.9
108	19.3	8.7	87.6	54.2	3,240	3.3

--Continued

Table 9.--Composition of individual samples of molasses from different sources, analyzed in Texas, 1958--Continued

Supplier of samples, source of molasses, and sample number	H_2O	Ash	Brix	Sugar	Viscosity	Protein
	Percent	Percent	Degrees	Percent	Centi-stokes	Percent
Puerto Rico (Cont.):						
109	16.2	7.2	89.8	59.8	5,000	5.7
110	20.5	10.6	87.0	50.1	1,354	4.3
California Department of Agriculture:						
Hawaii:						
427	18.8	9.9	85.5	51.1	1,989	3.5
428	18.4	8.4	87.3	56.5	2,262	2.3
Foreign areas: 3/						
134	18.8	5.5	85.2	62.3	1,465	2.4
165	18.1	6.6	86.9	66.3	1,069	1.2
426	16.3	10.4	90.8	56.3	2,955	2.9
Florida Department of Agriculture:						
Florida:						
168	17.0	9.0	88.5	55.2	12,396	8.6
169	20.4	11.0	87.6	50.1	1,555	9.1
170	20.8	9.3	86.9	52.5	1,320	7.7
171	20.6	10.1	85.6	54.7	1,601	6.4
172	21.0	11.4	87.2	50.4	1,176	9.4
173	20.8	9.8	86.3	49.4	1,227	15.4
174	26.2	8.8	81.4	48.5	227	7.2
175	27.4	8.6	78.4	48.8	154	7.3

3/ Ecuador, Nicaragua, and Philippines.

Richardson, Luther Ray, 1899–

Factors in developing grades and standards for blackstrap molasses for feed. [Washington] Marketing Research Division, Agricultural Marketing Service, U. S. Dept. of Agriculture [1959]

42 p. illus., tables. 27 cm. ([U. S. Dept. of Agriculture] Marketing research report no. 302)

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